Osteomyelitis in Trans-Metatarsal Amputation

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Background

Each year, about 1.6 million Americans with diabetes experience a foot ulcer; Approximately 50% become infected, and 20% of these need a lower-extremity amputation (1). Peripheral artery disease (PAD) and Osteomyelitis (OM) are the predominant causes of non-healing ulcers (2). Diagnostic measures for OM include plain radiographs (RAD), Magnetic Resonance Imaging (MRI), physical examination (PEX), histopathology (HPA), and bone bacterial culture (BC) from resected bones (3). Early detection of OM provides more successful treatment.

Aim

This study evaluates the Sensitivity (SEN), Specificity (SPE), Positive Predictive Value (PPV), and Negative Predictive Value (NPV) of RAD and PEX in diagnosing foot OM in patients undergoing trans-metatarsal amputation (TMA). The IRB approved the study for exempt status.

Methods

We reviewed the records of 275 patients who had TMAs from 2014 to 2023. The TMAs were performed due to the extent of the infection or gangrene. All specimens from the TMA procedures were sent to pathology and microbiology for confirmation of OM. RAD and PEX are performed for all patients. We used radiologists' reports for OM evaluation, describing cortical bone erosion as a sign of OM. We reviewed the medical records of PEX for the presence of OM, including a probe-to-bone test (PTB), exposed bone, redness, and swelling. For the purpose of this study, we consider HPA as diagnostic of osteomyelitis. The HPA test often takes 1 week to yield a result, and we use it to confirm OM. We calculated the sensitivity (SEN), specificity (SPE), positive predictive value (PPV), and negative predictive value (NPV) of RAD and PEX in diagnosing OM.

Results

142 of 275 patients had OM confirmed by HPA at the first surgery; 33 had positive HPA at the second surgery. Thus, 175 patients had positive HPA overall. RAD had 78 false negatives (FN), 20 false positives (FP), 98 true positives (TP), and 79 true negatives (TN). These give an SEN of 55.68%, a SPE of 79.79%, a PPV of 83.05%, and an NPV of 50.32%. The review of PEX yields 30 FN, 17 FP, 146 TP, and 82 TN. These give an SEN of 82.95%, an SPE of 82.82%, a PPV of 89.57%, and an NPV of 73.21%.

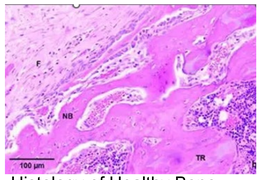
	TEST POSITIVE	TEST NEGATIVE
CONDITION POSITIVE	TRUE POSITIVE	FALSE NEGATIVE
CONDITION NEGATIVE	FALSE POSITIVE	TRUE NEGATIVE

Sensitivity = TP/(TP + FN)
Specificity = TN/(TN + FP)
Positive Predictive Value = TP/(TP + FP)
Negative Predictive Value = TN/(TN + FN)

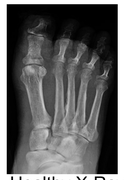
Disclosure

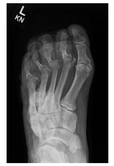
None.

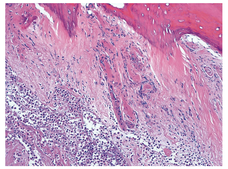
Photographs

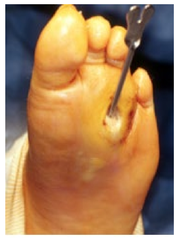


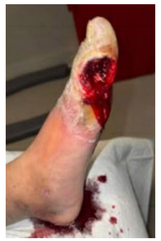
Histology of Healthy Bone

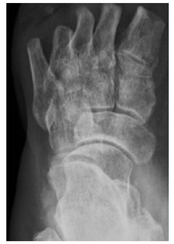

Healthy X-Rays

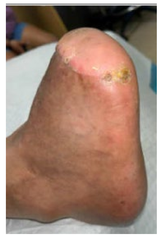

X-Rays OM


Histology of OM Bone


Probe-to-Bone


Exposed Bone


TMA


Healed TMA

Conclusion

Histopathological examination is the gold standard for diagnosing osteomyelitis. In this retrospective review of a safety-net institution, a combination of thorough PEX and RAD helped establish a diagnosis of OM, determine appropriate antibiotic

References

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Discussion

Although MRI is regarded as the most reliable imaging technique for diagnosing and evaluating the extent of OM, with a sensitivity and specificity in many studies. MRI is not typically used in our patients due to difficulty obtaining approval. An MRI can cost anywhere from $400 to $12,000 (4). We used RAD as the first imaging study to detect OM along with correlated PEX. RAD often is the first imaging study used to evaluate OM. Our radiologists looked for common OM changes, including osteopenia, periosteal thickening, cortical erosions, and new bone formation (5). It takes at least 30–50% bone loss to show visible changes on RAD, and such changes take at least 2–3 weeks to manifest (6). Our study showed that RAD had good specificity and positive predictive value.

PEX is important for diagnosing OM. Most studies focused only on PTB; our PEX included other aspects of OM, with good sensitivity and specificity. Many studies following the first study on PTB lacked a proper description of the PTB test; one must use a metal probe, such as a grooved probe, to detect the bone. An OM bone feels rough when palpated with a metal probe. If the bone still has an intact capsule, which gives a smooth sensation upon palpation, it is not OM. A soft probe, such as a cotton-tip applicator, does not provide a clear sensation for bone detection. In addition, the examiner needs to look for visible exposed bone; red, swollen “sausage” toe in the presence of an ulcer; an ulcer that is deep; and the presence of a soft tissue sinus with purulent discharge (7).

For this study, we used HPA for OM diagnosis and BC for backup. The amputated bones were sent to pathology and microbiology. The pathologists processed them according to their protocol. Pathologic features of OM observed in microscopic view, including infiltration of neutrophils and fibrosis, with necrotic bone and fibroconnective tissue exhibiting dense inflammation and abscess formation. The inflammatory infiltrate includes neutrophils, plasma cells, lymphocytes, and some foamy histiocytes (8). Thirty-three specimens were initially negative at the first surgery but were positive at the second surgery. These patients remained hospitalized and on treatment when the change was manifested, with an average of 9 days. They could not have developed new OM; they had delayed manifestation. To our knowledge, no study has reported delayed HPA manifestations of OM. Our data indicate it may be similar to the delayed manifestation observed on the radiograph. Some authors advocate the use of biopsy for diagnosing OM. BC samples are often contaminated when they pass through the infected area. Therefore, BC is useful for determining antibiotic regimen, but not diagnostic in this study.